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Application of thermomagnetic analysis to picroilmenite investigation

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Abstract

Picroilmenite samples from five kimberlite pipes of the Yakutian kimberlite province have been studied. Point microprobe analyses of two mutually perpendicular profiles of each sample were carried out to study the compositional inhomogeneity of picroilmenite. Thermomagnetic curves were also recorded for each sample. A model for the processing of thermomagnetic curves is proposed on the basis of the relationship between the Curie point of picroilmenite and the content of the hematite end-member. The compositions determined by the thermomagnetic curves and microprobe analysis are rather similar. The conclusion has been drawn that thermomagnetic analysis can be used for the rapid determination of the picroilmenite composition. The possibilities and restrictions of this method are shown.

Keywords: picroilmenite; thermomagnetic analysis; kimberlite; Curie point

Introduction

Ilmenite containing >9 wt.% MgO is referred to as picroilmenite (Garanin et al., 1984), an intermediate member of the isomorphous series of solid solutions hematite–ilmenite–geikielite (Fe_2O_3–$FeTiO_3$–$MgTiO_3$) (Kudryavtseva, 1988).

Picroilmenites, along with pyrope and garnet, are the most typical accessory minerals of kimberlite rocks. There are three hypotheses of the picroilmenite genesis in kimberlites (Alymova, 2006): (1) crystallization in the asthenospheric layer of the mantle, (2) disintegration of mantle xenoliths, and (3) crystallization from kimberlite melt.

Many researchers have noted the variability of picroilmenite composition in kimberlite pipes. Garanin et al. (1984) showed that megacrystallites from different diamondiferous provinces have different compositions. Alymova (2006) and Kostrovitsky et al. (2006) prove that the similar compositions of picroilmenite grains from different pipes of the same kimberlite cluster and the identical types of main-oxide distribution evidence the formation of picroilmenites of different pipes in the same magma chamber.

The composition of picroilmenite can also vary within a grain for various reasons: different *PT*-conditions of picroilmenite formation (Genshaft et al., 2000; Silaev et al., 2008); disintegration of primary picroilmenite into iron-enriched (close to hematite) and ilmenite-similar zones (such a zoning is rather rare (Garanin et al., 1984; Silaev et al., 2008); and reaction rims of polymineral composition, in which secondary ilmenite can also form (Amshinskii and Pokhilenko, 1983; Genshaft and Ilupin, 1982). The reaction rims often contain various spinels, e.g., Cr-spinels and titanomagnetites (Garanin, 1984; Genshaft et al., 2000; Kostrovitsky et al., 2006; Silaev et al., 2008).

Microprobe analysis is the main method for studying picroilmenites. It provides data on the composition of picroilmenites and reveals the grain phase inhomogeneity and mineral phase proportions.

Magnetic properties of picroilmenite

The magnetic properties of picroilmenites have been comprehensively studied (Garanin et al., 1984; Kolesnikov, 1970; Kudryavtseva, 1988). Kudryavtseva (1988) showed the Curie point of picroilmenites is dependant on the content of the hematite component (Fig. 1). Summarizing all available data, she reports that the Curie point also depends on the content

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